Marcus, Er. 1958. On western Atlantic opisthobranchiate gastropods. American Museum Novitates 1906:1–82.

Muniain, C., A. Valdés & J. Ortea. 1996. Redescription of *Tyrinna nobilis* Bergh, 1898 (Opisthobranchia: Chromodorididae) from Patagonia, Argentina. Journal of Molluscan Studies 62:265–273.

Ortea, J. 1988. Moluscos opistobranquios del Archipiélago de Cabo Verde: C[h]romodorididae. Publicações Ocasionais da Sociedade Portuguesa de Malacologia 11:1–16.

Schrödl, M. & S. V. Millen. 2001. Revision of the nudibranch gastropod genus *Tyrinna* Bergh, 1898 (Doridoidea: Chromodorididae). Journal of Natural History 35:1143–1171.

A new species of *Cuthona* Alder & Hancock, 1855, from the Gulf of California, Mexico (Opisthobranchia: Nudibranchia: Tergipedidae)

Orso Angulo Campillo

Departamento de Pesquerías y Biología Marina, Instituto Politécnico Nacional, Centro Interdisciplinario de Ciencias Marinas, Avenida I.P.N. s/n, Colonia Palo de Santa Rita, 23090 La Paz, Baja California Sur, Mexico; mol@cromwell.com.mx

and

Ángel Valdés

Natural History Museum of Los Angeles County, 900 Exposition Boulevard, Los Angeles, California 90007, USA; avaldes@nhm.org

The systematics of the family Tergipedidae have been extensively reviewed by Gosliner (1980) and Gosliner & Griffiths (1981), who provided a diagnosis of *Cuthona* Alder & Hancock, 1855, and comparison with the related genus *Catriona* Winckworth, 1941.

Behrens (1984) reported 12 species of Tergipedidae from the northeastern Pacific, but none of them were found in the Gulf of California. Later Behrens (1985) described *Cuthona longi*, the first species of Tergipedidae collected from the Gulf of California. More recently, Skoglund (2002), in her review of the Panamic opisthobranch fauna, reported only two species from this area: *Cuthona longi* Behrens, 1985, and an undescribed species illustrated by Behrens (1991) and collected from Bahia Tortugas, Pacific side of Baja California and the Gulf of California.

Figure 1. Holotype of *Cuthona **lizae*** Angulo & Valdés, sp. nov. (LACM 2951).

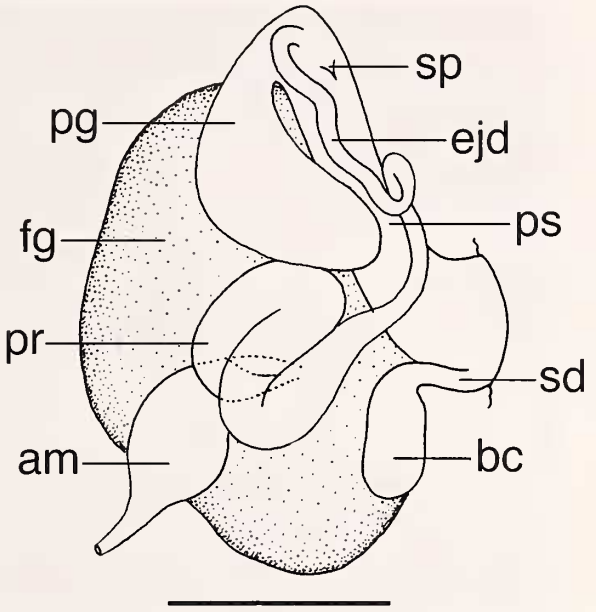

Figure 2. Reproductive system of a paratype of *C. **lizae*** Angulo & Valdés, sp. nov. (LACM 2952), scale bar = 1 mm, Abbreviations: am, ampulla; bc, bursa copulatrix; ejd, ejaculatory duct; fg, female glands; pg, penial gland; pr, prostate; ps, penial sac; sd, separate duct connecting to the bursa copulatrix; sp, penial spine.

The present paper describes a third species of *Cuthona* from the Gulf of California based on several specimens collected near La Paz. The material examined is deposited at the Natural History Museum of Los Angeles County (LACM).

Species Description

Tergipedidae Bergh, 1889
Cuthona Alder & Hancock, 1855

*Cuthona **lizae*** Angulo & Valdés, sp. nov.
(Figures 1–3)

Material examined: Holotype: Ensenada de Muertos, Baja California Sur, Mexico, 16 January 2002, 2 mm long, collected in an intertidal pool by O. Angulo (LACM 2951). Paratypes: Ensenada de Muertos, Baja California Sur, Mexico, 16 January 2002, 4 specimens 1.5, 1.8, 2.5 (dissected), and 2.8 mm long, collected in an intertidal pool by O. Angulo (LACM 2952).

External morphology: Body color reddish, with small,

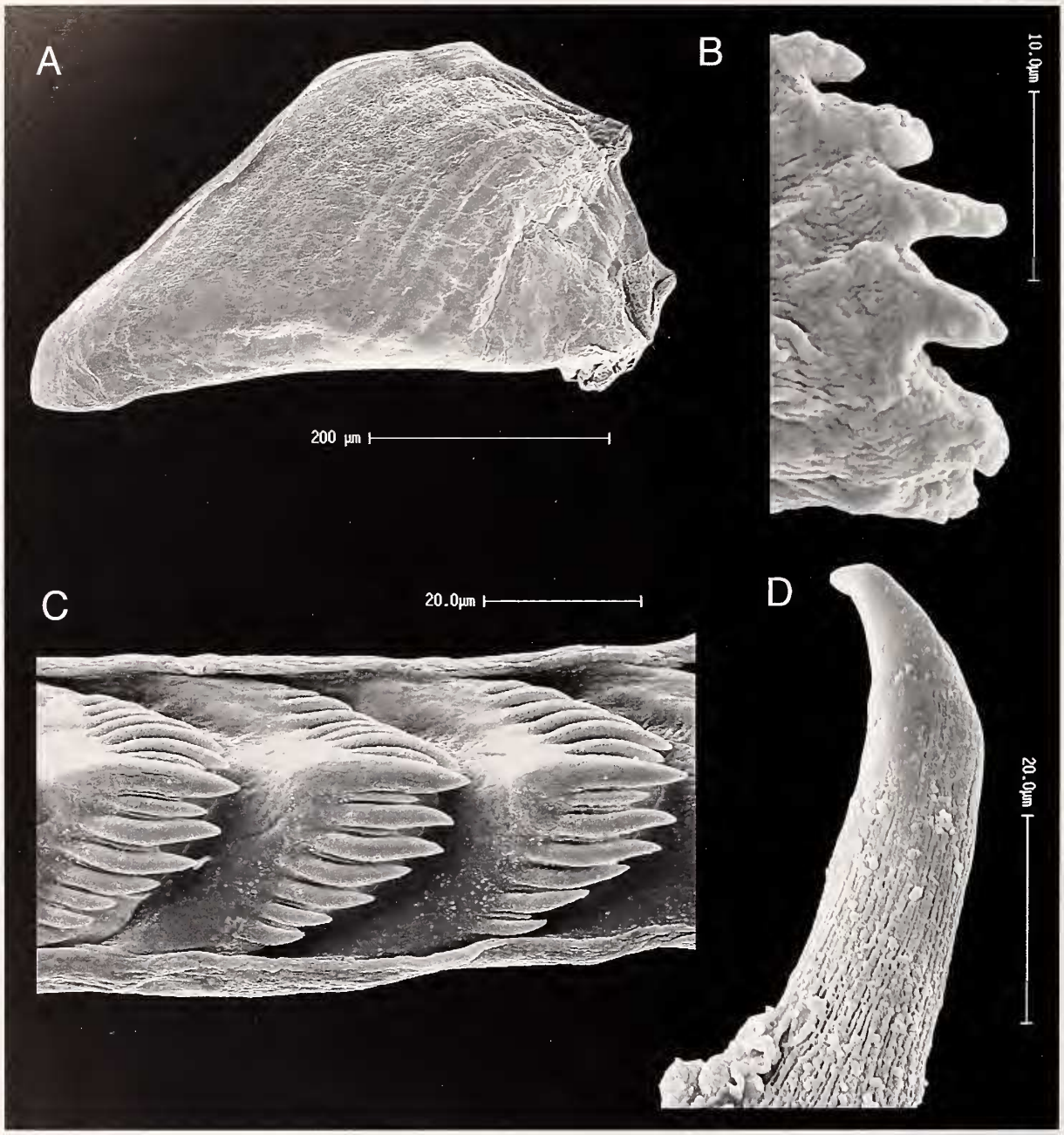

Figure 3. *Cuthona* ***lizae*** Angulo & Valdés, sp. nov., scanning electron micrographs of a paratype (LACM 2952). A. Jaw, scale bar = 200 µm. B. Masticatory border elements, scale bar = 10 µm. C. Radular teeth, scale bar = 20 µm. D. Penial spine, scale bar = 20 µm.

dusty, light blue spots all over the dorsum (Figure 1). A white spot, variable in size, is present in the middle of the dorsum, behind the first group of cerata. The rhinophores and oral tentacles are elongate and smooth, almost the same size. They have the same color as the body from the base to the middle region, but in some specimens there is a yellow band near the base, which can be entire (in larger specimens) or composed of small dots (in smaller specimens). The apical half of the rhinophores and oral tentacles is yellowish.

The cerata are arranged in three groups, one of them anterior to the pericardium with three to four rows of cerata and two to four cerata per row. The first group posterior to the pericardium has two to three rows of cerata with two to four cerata per row, and the second group has one to three rows of cerata with two to four cerata

per row. The cerata are slightly curved toward the dorsum. The cerata are sprinkled with yellowish spots. Near the tip some spots are more densely concentrated, forming a subapical ring. The digestive gland is visible inside of the cerata as a dark red mass.

The foot is elongated. The gonophore is situated on the right side of body, below the middle of the first group of cerata. The anus is situated near the middle region of the body, anterior to the post-cardiac ceras.

Anatomy: The reproductive system is diaulic (Figure 2). The ampulla is short and wide and connects to the female glands and the prostate. The prostate is long and convoluted. It narrows into the ejaculatory duct that expands again into the penial sac. A large penial gland is connected distally to the penial sac. The penis is armed with a copulatory spine (Figure 3D), about 60 μm long. There is a small separate duct that joins with the elongate-oval bursa copulatrix.

The radular formula is 23 × 0.1.0. Each tooth has a concave base and a central cusp (Figure 3C). There are six to seven strong denticles on each side of the cusp, with smaller and thinner denticles alternating with each larger denticle. The jaws are oval in shape (Figure 3A). The masticatory border of the jaws has six irregular nodulous denticles on its distal portion (Figure 3B).

Etymology: The specific name *lizae* is given in honor of Liza Gómez, for her unconditional support and enthusiasm during the field trips during which this new species was collected.

Discussion

The generic placement of *Cuthona* ***lizae*** is based upon the presence of a penial gland and penial spine, which are characteristic of the Tergipedidae, the absence of bristles on the masticatory border of the jaws and the possession of only 23 radular teeth (less than 50), which are characteristic of *Cuthona* (Gosliner, 1980; Gosliner & Griffiths, 1981). *Cuthona* ***lizae*** is distinguishable from other members of the genus in several regards.

The characteristic red color of *C.* ***lizae*** seems to be unique to this species, and only one undescribed species of the genus, from the tropical Indo-Pacific, shares a reddish coloration with *C.* ***lizae*** (see Coleman, 2001:109). However, the cerata of the undescribed Indo-Pacific species are straight, instead of curved, and they are not covered with yellow spots. Another difference between these two species is the presence of a white band that runs from the cephalic region to the foot in the undescribed Indo-Pacific species.

Another characteristic feature of *C.* ***lizae*** is the presence of a large white spot situated behind the first group of cerata. The only other species of *Cuthona* that have a white spot on the dorsum are *Cuthona albocrusta* (MacFarland, 1966) and *Cuthona abronia* (MacFarland, 1966). The color pattern of *C.* ***lizae*** resembles that of *C. abronia,* except that in *C. abronia* the red is replaced with brown, the white spot is present on the cephalic region, between the oral tentacles, and there is no large white spot in the central region of the body. *Cuthona* ***lizae*** and *C. abronia* also share a band around the rhinophores and oral tentacles, but the two species differ in radular morphology, the teeth of *C. abronia* being irregular in shape and lacking the thinner denticles alternating with the larger denticles in *C.* ***lizae*** (see Roller, 1969). Additionally, these two species differ in the number of denticles on the masticatory border of the jaws: *C. abronia* has 17 denticles, whereas *C.* ***lizae*** has only six denticles. In the original description of *C. abronia* by MacFarland (1966), there is no mention of any penial gland or penial stylet which is characteristic of all members of the Tergipedidae.

Cuthona albocrusta is distinguishable from *C.* ***lizae*** in the number of radular teeth. There are between 49–70 teeth in *C. albocrusta* (Behrens, 1985, 1991) and only 23 in *C.* ***lizae***. In addition, the white frosting markings on the body and cerata of *C. albocrusta* are absent from *C.* ***lizae***, which has bluish spots on the dorsum and yellowish dots on the cerata.

The only other species known from the Gulf of California has been illustrated by Behrens (1991) but not named yet. This species differs from *C.* ***lizae*** in having a yellow-orange body with a light blue patch on the head. The lower half of the cerata is black, with a blue band, and the distal portion has a yellow tip (Behrens, 1991).

Acknowledgments. We thank several individuals who supported the senior author during his field work: Liza Gómez, Juan F. Elorduy, Ricardo Saldierna, Adriana Calapiz, Oscar Trujillo, and Enrique Calvillo.

This paper has been supported by the grant #CGPI 20010306 from the Instituto Politécnico Nacional, La Paz, and a travel grant from the Natural History Museum Los Angeles County to the senior author.

Literature Cited

Behrens, D. W. 1984. Notes on the tergipedid nudibranchs of the northeastern Pacific with a description of a new species. The Veliger 27:65–71.

Behrens, D. W. 1985. A new species of *Cuthona* from the Gulf of California. The Veliger 27:418–422.

Behrens, D. W. 1991. Pacific Coast Nudibranchs: a Guide to the Opisthobranchs, Alaska to Baja California. 2nd ed. Sea Challengers: Monterey, California. 107 pp.

Coleman, N. 2001. 1001 Nudibranchs. Catalogue of Indo-Pacific Sea Slugs. Neville Coleman's Underwater Geographic Pty: Springwood, Australia. 144 pp.

Gosliner, T. M. 1980. The Systematics of the Aeolidacea (Nudibranchia: Mollusca) of the Hawaiian islands, with descriptions of two new species. Pacific Science 33:37–77.

Gosliner, T. M. & R. J. Griffiths. 1981. Description and revision of some South African aeolidacean Nudibranchia (Mollusca, Gastropoda). Annals of the South African Museum 84:105–150.

MacFarland, F. M. 1966. Studies of opisthobranchiate mollusks of the Pacific coast of North America. Memoirs of the California Academy of Sciences 6:i–xvi + 1–546.

Roller, R. A. 1969. Nomenclatural changes for the new species Assigned to *Catrena* by MacFarland, 1966. The Veliger 11: 421–423.

Skoglund, C. 2002. Panamic Province molluscan literature. Additions and changes from 1971 through 2001. III Gastropoda. The Festivus 33(supplement):i–xi, 1–286.

Effects of Larval *Echinostoma caproni* and *Schistosoma mansoni* Infection on the Heart Rate of *Biomphalaria glabrata* Snails

Bernard Fried* and Yonghyun Kim

Department of Biology, Lafayette College, Easton, Pennsylvania 18042, USA

Introduction

Lee & Cheng (1970, 1971) reported that infection with larval *Schistosoma mansoni* Sambon, 1907, increased the heart rate of *Biomphalaria glabrata* (Say, 1816) snails maintained at 23°C to 33°C. Williams & Gilbertson (1983a, b) indicated that both feeding and locomotion influenced the heart rate of *B. glabrata* and the infection status with *S. mansoni* was not a major factor in altering the rate. The purpose of our study was to examine the heart rate of *B. glabrata* infected with either *S. mansoni* or *Echinostoma caproni* Richard, 1964, larval stages.

Materials and Methods

Our snails were maintained at 23 ± 1°C as described previously (Fried et al., 2001) in glass cultures each containing 1000 mL of artificial spring water (ASW). The ASW was prepared as described by Ulmer (1970). The number of snails per culture ranged from 10 to 20, and snails were fed romaine leaf lettuce ad libitum; the water was changed twice a week. Snails (about 5 week old and 4 ± 1 mm in shell diameter) were infected with either the miracidia of *S. mansoni* or the miracidia of *E. caproni* as described by Fried et al. (2001) and Idris & Fried (1996), respectively. Snails released cercariae of either *S. mansoni* or *E. caproni* at 7 week postinfection (p.i.) and were marked with nail polish to identify them. All determinations of heart rate were made at room temperature (23 ± 1°C) with snails in a 3 cm diameter plastic Petri dish containing 2–3 mL of ASW; the number of heart beats per min was counted under a dissecting microscope; observations were made between 1000 and 1400 hr.

* To whom correspondence should be addressed: Telephone: (610) 330-5463; Fax: (610) 330-5705; friedb@lafayette.edu

Table 1

Effects of *Schistosoma mansoni* (Sm) and *Echinostoma caproni* (Ec) infection on the heart rate of *Biomphalaria glabrata* snails.

Experiment	Age of snails (wk)	No. of snails	Mean ± SE heart beat/min	Age of snails (wk)[1]	No. of snails	Mean ± SE heart beat/min
	Uninfected			Infected with Sm		
1	13	5	27.4 ± 2.2	13	5	27.4 ± 1.0
2	14	10	33.6 ± 1.9	14	10	35.2 ± 2.6
3	15	10	36.3 ± 1.5	15	10	29.1 ± 1.3*
				Infected with Ec cercariae and rediae		
4	15	10	36.2 ± 1.6	15	10	32.2 ± 2.3
				Infected with cysts of Ec		
5	15	10	36.4 ± 1.4	15	10	23.8 ± 0.8*

[1] Snails were exposed to miracidia at 5 wk of age in Experiment 1–4 and examined from 8 to 10 wk p.i. In Experiment 5, snails were exposed to cercariae of *E. caproni* at 14 wk of age and examined 1 wk p.i.

* Measurements were significantly less (Student's *t*-test, $P < 0.05$) in the infected groups than in the control groups.

To obtain large numbers of metacercarial cysts in the kidney-pericardial region of *B. glabrata,* uninfected snails (about 10 to 12 mm in shell diameter) were placed in cultures (typically five to 10 uninfected snails) with several *B. glabrata* snails releasing *E. caproni* cercariae. The uninfected snails accumulated 500 to 1000 metacercarial cysts per snail in the kidney-pericardial region within 1 week p.i. In experiments to determine if snails with metacercarial cyst infection had altered heart rates, these snails were matched with uninfected *B. glabrata* snails of the same size (Experiment 5, Table 1).

Results and Discussion

Because Lee & Cheng (1971) noted that young uninfected *B. glabrata* had faster heart rates than older snails, we matched young snails (7 mm in shell diameter) against older snails (12 mm in shell diameter) and determined the heart rates. The heart rate of the young snails (n = 5) was 47.8 ± 2.4 beats per min compared to 27.4 ± 2.2 beats per min for the older snails (n = 5). The Student's *t*-test indicated a significant difference ($P < 0.05$) in the above values, supporting the earlier finding of Lee & Cheng (1971) that younger snails had significantly greater heart rates than older ones.

To test the effects of *S. mansoni* larval infection on *B. glabrata,* control and infected snails of a similar size, about 12 ± 1 mm shell diameter, were matched at 8 to 10 week p.i. ([see] Table 1, Experiments 1, 2 & 3). We found no significant difference (Student's *t*-test, $P > 0.05$) in the heart rates of *S. mansoni* infected vs. control snails at 8 and 9 week p.i. (Experiments 1 & 2). In fact, the